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Roberge et al.

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(54) **METHOD AND SYSTEM FOR DATA USAGE ACCOUNTING IN A COMPUTING DEVICE**

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This patent is subject to a terminal disclaimer.

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G06F 15/173 (2006.01)
H04L 29/08 (2006.01)

(52) **U.S. Cl.**
CPC ***H04L 67/22*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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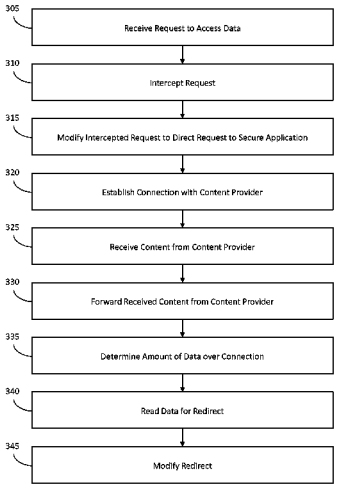
(57) **ABSTRACT**

A method and system for data usage accounting are described herein. As an example, the method can be practiced in a setting that includes both secure applications and unsecure applications. Via one of the secure applications, a request to access data can be received in which the request is intended for a content provider via a system service. The request that is intended for the content provider via the system service can be intercepted and modified, which can cause the system service to direct the request back to the secure application instead of the content provider. In addition, a connection can be established with the content provider for the request through the secure application to enable data usage accounting of data that is returned by the content provider.

26 Claims, 4 Drawing Sheets



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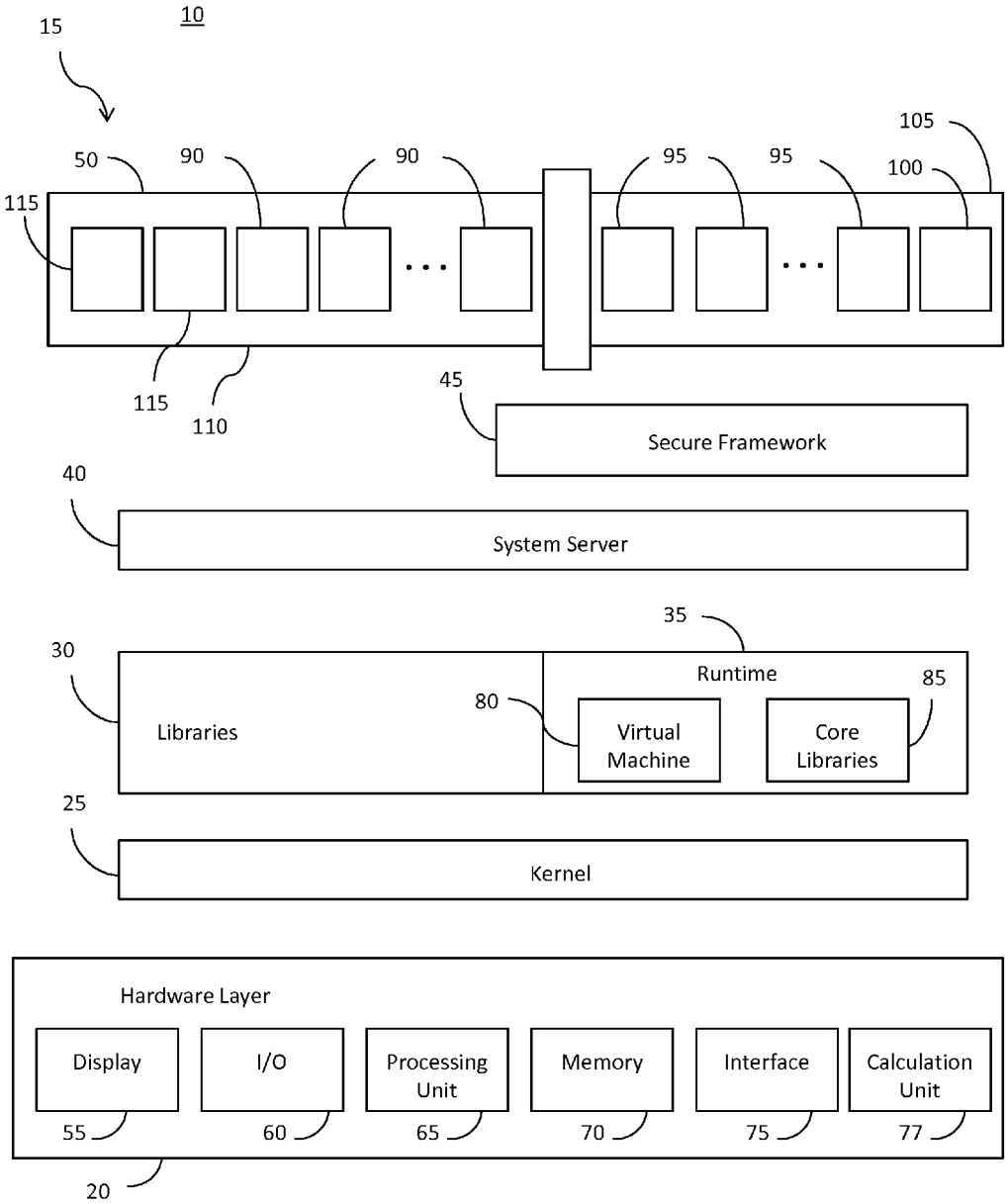
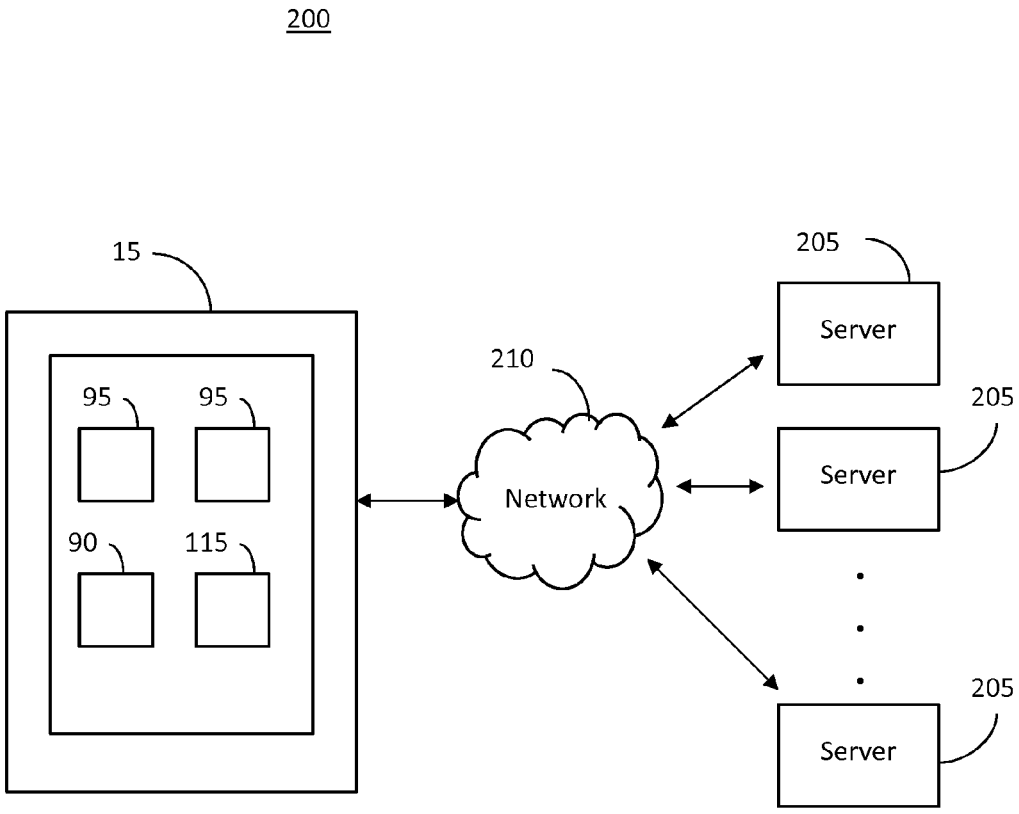

10
15
105
50
90
90
95
95
100
115
115
110
45
Secure Framework
40
System Server
35
30
Runtime
85
80
Libraries
Virtual Machine
Core Libraries
25
Kernel
Hardware Layer
Display
I/O
Processing Unit
Memory
Interface
Calculation Unit
55
60
65
70
75
77
20

FIG. 1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Network
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Server
205
Server
205
Server

FIG. 2

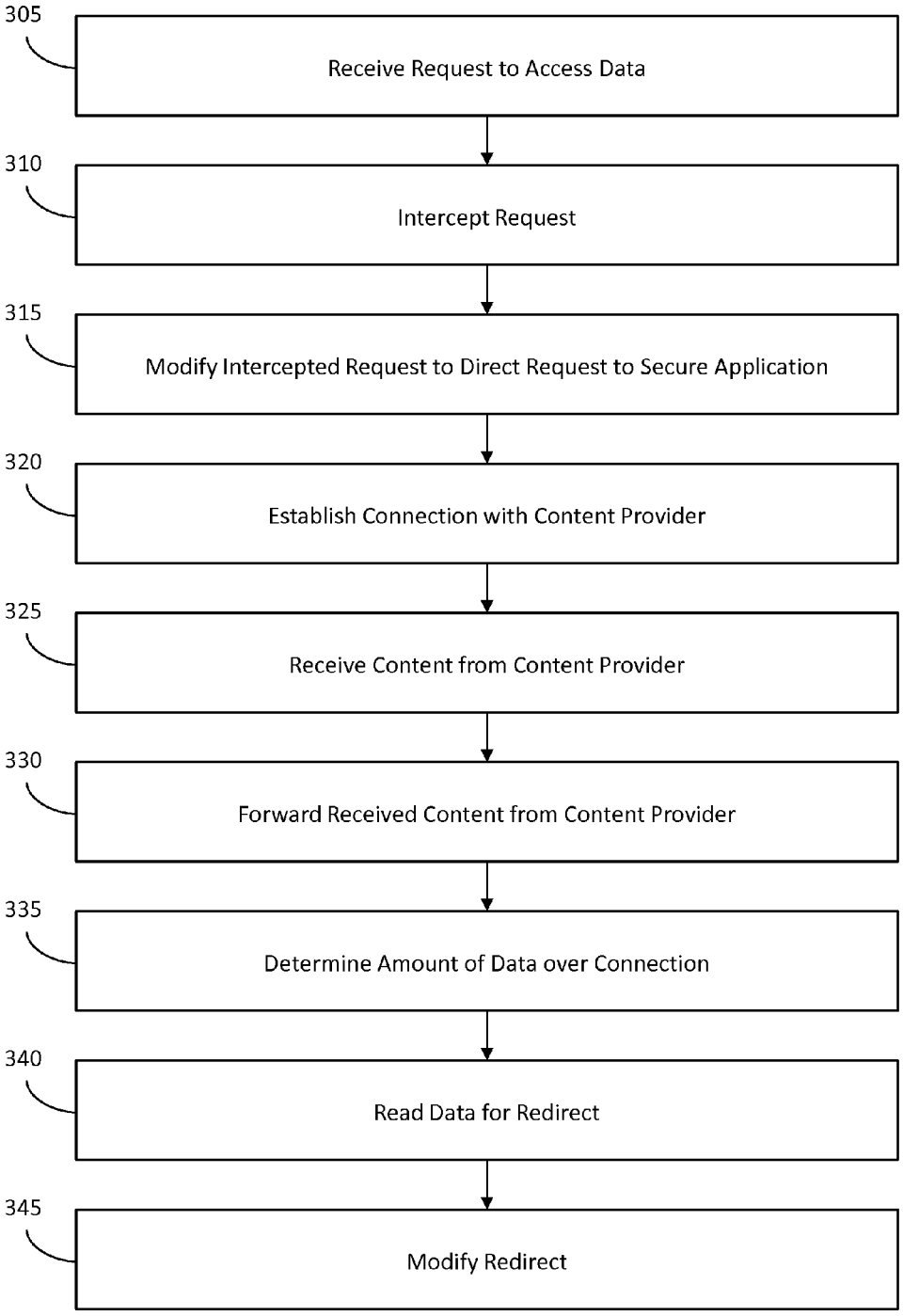
305
Receive Request to Access Data
310
Intercept Request
315
Modify Intercepted Request to Direct Request to Secure Application
320
Establish Connection with Content Provider
325
Receive Content from Content Provider
330
Forward Received Content from Content Provider
335
Determine Amount of Data over Connection
340
Read Data for Redirect
345
Modify Redirect

FIG. 3

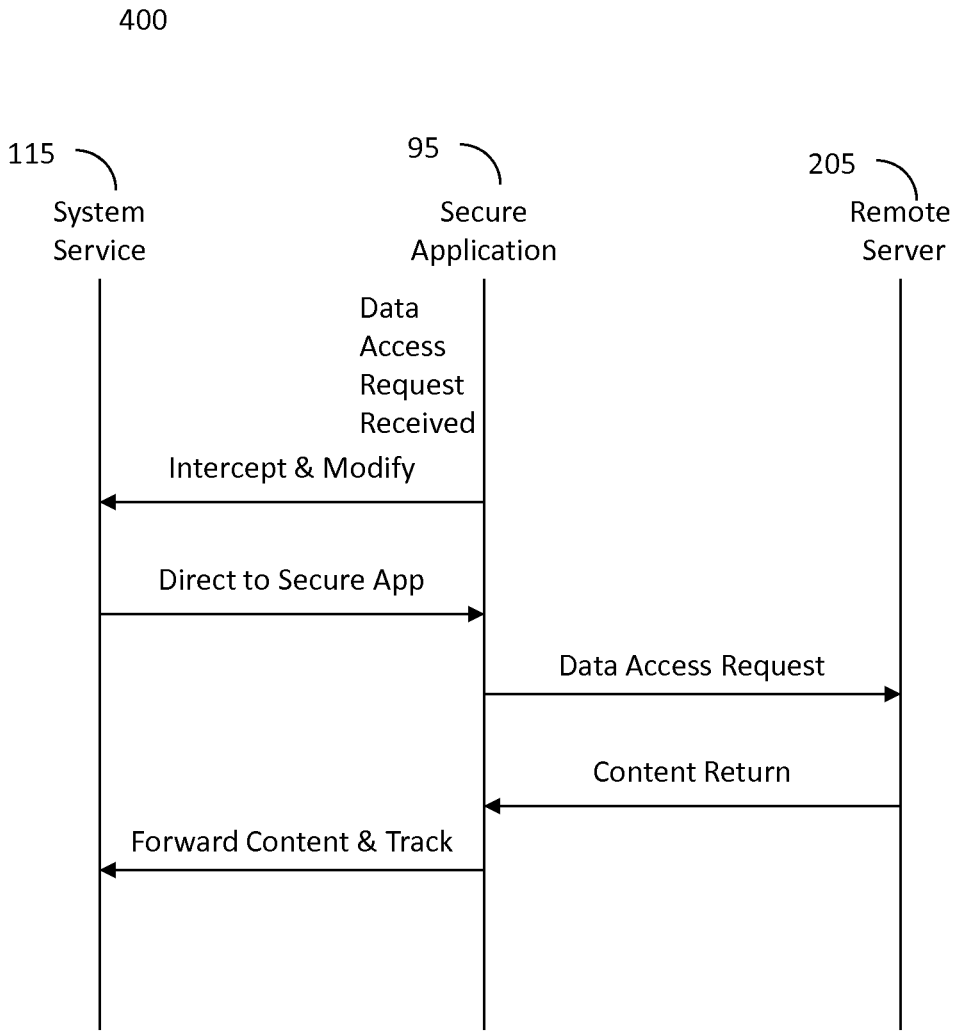
400
115
System Service
95
Secure Application
205
Remote Server
Data Access Request Received
Intercept & Modify
Direct to Secure App
Data Access Request
Content Return
Forward Content & Track

FIG. 4

METHOD AND SYSTEM FOR DATA USAGE ACCOUNTING IN A COMPUTING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application is a continuation of U.S. patent application Ser. No. 14/478,066, filed on Sep. 5, 2014, which is incorporated herein by reference in its entirety.

FIELD OF TECHNOLOGY

The present description relates to methods and systems for data usage accounting and more particularly, to methods and systems for data usage accounting in computing devices with secure enterprise applications and personal applications.

BACKGROUND

In an effort to increase productivity, many employers allow their workers to conduct business related to the employer on their personal mobile devices. In some cases, employers also provide some of their employees with company-issued mobile devices. In either arrangement, an employer understands that a single device may include sensitive data related to that employer in addition to data that is personal to the employee. Several advances have been made in an effort to protect an employer's data in these circumstances. For example, OpenPeak Inc. of Boca Raton, Fla. has developed solutions that enable a mobile device to include both enterprise and personal data but that isolate the enterprise data from the personal data. As part of these solutions, an employee may download secure applications that may be used to conduct transactions related to the enterprise.

Because the employee's device may include both personal and secure applications, it may be necessary to bifurcate the process of data usage accounting. In particular, the employer may wish to receive an accounting of the data usage associated with the secure applications that have been installed on the employee's device on behalf of the employer. This accounting may be separate from data accounting that may be attributable to unsecure applications that the employee may have installed for personal use. Unfortunately, there is no solution available for tracking data usage with respect to certain system services that may be requested by the secure applications.

SUMMARY

A method of data usage accounting is described herein. This method may be particularly applicable in a setting that includes both secure applications and unsecure applications, although it is not limited to such a configuration. Via one of the secure applications, a request to access data can be received in which the request is intended for a content provider via a system service. The request that is intended for the content provider via the system service can be intercepted and modified to cause the system service to direct the request back to the secure application instead of the content provider. Further, a connection can be established with the content provider for the request through the secure application to enable data usage accounting of data that is returned by the content provider. An amount of data that is carried over the established connection and that is associated with the secure application can be determined. As an example, the amount of data that is determined in relation to the secure application can be separate from an amount of data that is determined on behalf of one or more unsecure applications.

Establishing the connection with the content provider can include establishing a secure connection with the content provider through the secure application. As an example, the secure connection with the content provider can be a virtual private network (VPN) connection that is individual to the secure application. The method can also include the steps of receiving content from the content provider at the secure application and forwarding the received content from the content provider to the system service for processing. As another example, modifying the intercepted request can include modifying an original uniform resource identifier (URI) of the request by changing the URI associated with the content provider.

In another embodiment, the method can also include the steps of receiving data from the content provider over the established connection and reading the data to determine whether a redirect from the content provider is present. If (or when) a redirect from the content provider is detected, the redirect from the content provider can be modified to ensure that the system service will direct the redirect to the secure application. Receiving data from the content provider may include receiving from the content provider a playlist that includes a plurality of original URIs, and modifying the redirect can include modifying at least some of the URIs of the playlist. In one non-limiting example, the system service can be a media playback service, and the media playback service is a system application that is also an unsecure application.

Another method of data usage accounting in a computing device that has one or more secure applications installed thereon is presented herein. This method can include the steps of receiving an original URI request through one of the secure applications, intercepting the original URI request and modifying the original URI request such that the modified original URI request is to be directed back to the secure application once the modified original URI request has been initially processed by a system service. The method can also include the step of tracking data usage associated with the modified original URI request.

In one embodiment, the modified original URI request can be converted back to the original URI request and a connection can be established between the secure application and a content provider for the original URI request. The computing device can also have one or more unsecure applications installed thereon. Tracking data usage associated with the modified original URI can include tracking data usage associated with the modified original URI through the secure application. The method can also include the step of segregating the data usage tracking associated with the modified original URI from data usage tracking associated with the unsecure applications. Moreover, establishing the connection between the secure application and the content provider can include establishing a secure connection between the secure application and the content provider. As an example, the secure connection can be individual to the secure application.

Yet another method of data usage accounting on a computing device is described herein. On a computing device that has secure applications and unsecure applications installed thereon, multiple sessions of the secure applications can be conducted. An amount of data that is consumed during the sessions of the secure applications can be determined. A data usage total can be tallied for the secure application sessions such that the data usage total for the secure applications is separate from a data usage total associated with the unsecure applications.

A computing device is also described herein. The computing device can include a display that is configured to display both secure and unsecure applications that are installed on the computing device. The device can also include a processing unit that is communicatively coupled to the display. The processing unit can be configured to receive a data access request through one of the secure applications in which the data request is supported by an unsecure application that is a system service of the computing device. The processing unit can also be configured to cause the data access request to be intercepted prior to processing by the unsecure application and to cause the data access request to be modified. Such a modification can cause the unsecure application to direct the data access request to the secure application instead of an intended location of the data access request. The processing unit can also be configured to cause a connection between the secure application and the intended location of the data access request to be established. The computing device may also include a calculation unit communicatively coupled to the processing unit. The calculation unit can be configured to determine an amount of data that is associated with the data access request through the secure application.

As an example, the connection between the secure application and the intended location of the data access request can be a VPN connection that is individual to the secure application. As another example, the data access request can be a uniform resource locator (URL) based on hypertext transfer protocol (HTTP) or hypertext transfer secure protocol secure (HTTPS). The computing device can also include memory that can be associated with the secure application and can be configured to store the data access request for mapping the data access request to the modified data access request. In one embodiment, the processing unit can be further configured to convert the modified data access request back to its original form to establish the connection between the secure application and the intended location.

Further features and advantage, as well as the structure and operation of various embodiments, are described in detail below with reference to the accompanying drawings. It is noted that this description is not limited to the specific embodiments presented herein. Such embodiments are provided for illustrative purposes only. Additional embodiments will be apparent to persons skilled in the relevant art(s) based on the teachings contained herein.

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES

The accompanying drawings, which are incorporated herein and form part of the specification, illustrate embodiments of the subject matter described herein and, together with the description, further serve to explain the principles of such subject matter and to enable a person skilled in the relevant art(s) to make and use the subject matter.

FIG. **1** illustrates an example of a block diagram of the system architecture of a computing device that is configured to practice the subject matter described herein.

FIG. **2** illustrates an example of a system that shows the computing device of FIG. **1** in communication with one or more remote servers.

FIG. **3** illustrates an example of a method for data usage accounting.

FIG. **4** illustrates an example of an interaction between a secure application, a remote server and a system service.

The features and advantages of the embodiments herein will become more apparent from the detailed description set forth below when taken in conjunction with the drawings, in which like reference characters identify corresponding elements throughout. In the drawings, like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements.

DETAILED DESCRIPTION

The following detailed description refers to the accompanying drawings that illustrate exemplary embodiments; however, the scope of the present claims is not limited to these embodiments. Thus, embodiments beyond those shown in the accompanying drawings, such as modified versions of the illustrated embodiments, may nevertheless be encompassed by the present claims.

References in the specification to "one embodiment," "an embodiment," "an example embodiment," "one arrangement," "an arrangement" or the like, indicate that the embodiment or arrangement described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment or arrangement. Furthermore, when a particular feature, structure, or characteristic is described in connection with an embodiment or arrangement, it is submitted that it is within the knowledge of one skilled in the art to implement such feature, structure, or characteristic in connection with other embodiments or arrangements whether or not explicitly described. The word "among," as it is used throughout this description, should not necessarily be interpreted as requiring exchanges or interaction among three or more applications, irrespective of grammar rules. The word "a" is not necessarily limited to a singular instance of something, as it may mean one or more.

Several definitions that apply throughout this document will now be presented. The term "exemplary" as used herein is defined as an example or an instance of an object, apparatus, system, entity, composition, method, step or process. The term "communicatively coupled" is defined as a state in which two or more components are connected such that communication signals are able to be exchanged (directly or indirectly) between the components on a unidirectional or bidirectional (or multi-directional) manner, either wirelessly, through a wired connection or a combination of both. A "computing device" is defined as a component that is configured to perform some process or function for a user and includes both mobile and non-mobile devices. The term "computer readable storage medium" is defined as one or more components that are configured to store instructions that are to be executed by one or more processing units.

An "application" is defined as a program or programs that perform one or more particular tasks on a computing device. Examples of an application include programs that may present a user interface for interaction with a user or that may run in the background of an operating environment that may not present a user interface while in the background. The term "operating system" is defined as a collection of software components that directs a computing device's operations, including controlling and scheduling the execution of other programs and managing storage, input/output and communication resources. A "processing unit" or "processor" is defined as one or more components that execute sets of instructions, and the components may be disparate parts or part of a whole unit and may not necessarily be located in the same physical location.

The terms "memory," "memory element" or "repository" are defined as one or more components that are configured to store data, either on a temporary or persistent basis. The term

"shared memory" is memory, a memory element or a repository that is accessible (directly or indirectly) by two or more applications or other processes. An "interface" is defined as a component or a group of components that enable(s) a device to communicate with one or more different devices, whether through hard-wired connections, wireless connections or a combination of both. An "input/output device" is defined as a device that is configured to at least receive input from a user or a machine that is intended to cause some action or other effect on a component with which the input device is associated. A "display" is defined as an apparatus that presents information in visual form and may or may not receive input through a touch screen.

The term "file system" is defined as an abstraction that is used to organize, store and retrieve data. The term "secure application" is defined as an application that has been modified from its original form to restrict communications between the application and unauthorized programs, applications or devices and to restrict operation of the application based on policy or to alter, augment or add features associated with the operation of the application (or any combination thereof) or—in the case of the application not being modified—an application that is part of a secure workspace that is protected from data exchanges with applications that are part of a personal or an unsecure workspace. A "target application" is defined as an application that has been selected for conversion into a secure application. An "unsecure application" is defined as an application that has not undergone the modification required to convert the application into a secure application and, as such, is unable to obtain data from a secure application in view of an obfuscation scheme employed by that secure application or is an application that is not part of a secure workspace and is restricted from accessing data from the secure workspace. A "virtual machine" is defined as a platform-independent execution environment that emulates a physical machine.

The term "personal workspace" is defined as a workspace, profile or partition that is configured to contain the personal content and unsecure applications or other unsecure programs associated with a user of a computing device on which the personal workspace sits. The term "secure workspace" is defined as a workspace, profile or partition that is configured to contain secure content, secure applications and other secure programs and requires some form of authentication to be accessed.

The term "content provider" is defined as a site that offers data for consumption by a computing device. The term "system service" is defined as an application or a set of applications on a computing device that offer one or more features for access by an unsecure application or a secure application. A "secure connection" is defined as a connection in which at least some portion of the data that is exchanged over the connection is encrypted or otherwise obfuscated from unauthorized parties, entities or processes. To "consume data" means to receive data from a source, transmit data to a recipient or both.

As explained earlier, solutions have been developed that enable a mobile device to include both personal and enterprise data. Accordingly, it may be useful to segregate data usage accounting associated with the enterprise side from usage associated with the personal space. This process can enable an enterprise to determine how much data that is consumed by the mobile device is the responsibility of the enterprise.

In view of this need, a method and system for data usage accounting are described herein. As an example, the method can be practiced in a setting that includes both secure applications and unsecure applications. Via one of the secure applications, a request to access data can be received in which the request is intended for a content provider via a system service. The request that is intended for the content provider via the system service can be intercepted and modified, which can cause the system service to direct the request back to the secure application instead of the content provider. In addition, a connection can be established with the content provider for the request through the secure application to enable data usage accounting of data that is returned by the content provider.

Through this arrangement, data tracking can be conducted for virtually any secure application or otherwise any application associated with an enterprise. This tracking can also be kept apart from any accounting performed for a user's personal usage. Accordingly, an enterprise can accurately determine its accountability for data usage by a computing device that includes both enterprise and personal data.

Referring to FIG. **1**, an example of a block diagram **10** of the system architecture of a computing device **15** is shown. In this arrangement, the computing device **15** can include a hardware layer **20**, a kernel layer **25** and a libraries layer **30**, which may include a plurality of native libraries. This architecture may also include a runtime environment **35**, a system server **40**, a secure framework **45** and an application layer **50**.

In one arrangement, the hardware layer **20** may include any number and type of hardware components, such as one or more displays **55**, one or more input/output (I/O) devices **60**, one or more processing units **65** and any suitable type and number of memory devices **70** and interfaces **75**. Examples of the I/O devices **60** include speakers, microphones, physical keypads, etc. In addition, the display **55** can serve as an I/O device **60** in the form of a touch-screen display. The interfaces **75** can be configured to support various types of communications, including wired or wireless and through any suitable type of standards and protocols. In one arrangement, the hardware layer **20** may also include a calculation unit **77**, which can be configured to calculate or determine (or at least assist in the determination or calculation of) data usage totals associated with any type of session conducted on the computing device **15**, including those originating from the application layer **50**. The calculation unit **77** may be a separate component or may be part of the processing unit **65**. In another arrangement, the calculation unit **77** may be remotely located such that it is external to the computing device **15**. In such a case, information regarding the sessions may be sent to a remote location that supports the calculation unit **77**, and the unit **77** can perform its calculation functions once it receives the information.

In addition, the runtime environment **35** can support any suitable number of virtual machines **80** and core libraries **85**, although a virtual machine may not be needed in other arrangements, such as where native code is employed. The system server **40** can serve as an abstraction for the underlying layers for the applications in the application layer **50** and can provide numerous system services for the applications. In this example, the application layer **50** may include any number of unsecure applications **90** and any number of secure applications **95**, one of which may be a core secure application **100**. The secure framework **45** can function in a manner similar to that of a conventional framework, but the secure framework **45** can facilitate the encapsulation of a number of secure applications **95** to selectively restrict their data exchanges with the unsecure applications **90**. In particular, the secure framework **45** can be configured to intercept and modify certain calls from the secure applications **95**, prior to passing them to the system server **40**.

In many cases, the unsecure applications **90** are associated with the personal data of a user of the computing device **15**. In contrast, the secure applications **95** are typically associated with confidential or otherwise sensitive information that belongs to or is associated with an enterprise or some other organization, and the user of the device **15** may work for such an entity. In one arrangement, a virtual partition or workspace may be created on the computing device **15** in which the secure applications **95** (and the core secure application **100**) are part of a secure workspace **105**, and the unsecure applications **90** are part of a personal workspace **110**. In certain cases, a user may be required to provide authentication information, such as a password, PIN or biometric data, to gain access to the secure workspace **105** or to any individual or group of secure applications **95**.

In some cases, some of the unsecure applications **90** may be system services **115** that provide features or functionality that is associated with the type of operating system that is installed on the computing device **15**. In some cases, the system service **115** may be an application or a set of applications that live in the background and support different tasks associated with the operating system of the device **15**. System services **115** may facilitate the exposure of low-level functions of the hardware layer **20** and the kernel layer **25** to the higher-level application layer **50**. Many system services **115** may operate with elevated privileges, in comparison to other applications. For example, a common system service **115** that is typically found on computing devices **15** is a media player, which processes and presents media data for a user. Another example of a system service **115** may be a photo viewer, which presents digital images for the user. As those skilled in the art will appreciate, the examples listed here are not meant to be limiting, and there are other system services **115** that may be available on the computing device **15**.

In another embodiment, the system services **115** may be trusted unsecure applications **90** that secure applications **95** are permitted to share or otherwise exchange data with. An example of a trusted unsecure application **90** may be an unsecure application **90** that is by default installed on the computing device **15**, such as by the manufacturer of the device **15** or a wireless carrier or other entity that provides services to the device **15**. Another example of a trusted unsecure application **90** may be an unsecure application **90** that is listed on an application whitelist for one or more secure applications **95**. By being part of the application whitelist, the trusted unsecure application **90** may be preapproved for data exchange with the relevant secure application(s) **95**. Additional information on application whitelisting can be found in U.S. patent application No. 61/973,898, filed on Apr. 2, 2014, which is incorporated by reference herein in its entirety.

As noted above, the secure applications **95** and the system architecture may be configured to enable at least some of the calls to the system server **40** to be intercepted. There are several processes available for such a process. For example, U.S. patent application No. 62/033,142, which was filed on Aug. 5, 2014 and is herein incorporated by reference in its entirety, describes a method and system in which some of the system classes are overridden by classes associated with the core secure application **100**, which can allow runtime hooks to be applied against certain system calls. Based on this technique, some of the calls that the secure applications **95** make to the system services **115** can be intercepted and modified, a process that will described below.

As another example, U.S. patent application Ser. No. 14/205,661, which was filed on Mar. 12, 2014, and U.S. patent application Ser. No. 14/205,686, which was also filed on Mar. 12, 2014, each of which is herein incorporated by reference in its entirety, present methods and systems by which target applications are encapsulated as secure applications for distribution. Once installed and initiated on a computing device **15**, the encapsulated application described in these references is loaded into memory, and runtime hooks are set to enable application programming interface (API) calls from the secure application to be intercepted. Similar to the description above, at least some of the calls to the system services **115** from the secure applications **95** can be modified once they are intercepted. Other information on the process of intercepting certain functions of secure applications can be found in U.S. Pat. No. 8,695,060, issued on Apr. 8, 2014, which is also herein incorporated by reference in its entirety.

As described in these incorporated references, a secure application **95** can be configured to provide additional features that may not have been otherwise available prior to it being converted into a secure application **95**. As an example, a secure application **95** can be arranged to track the amount of data that it uses for a particular session. This process enables an administrator to determine data usage on a per-application basis. Of course, secure applications **95** may be managed in accordance with many other policies or configurations, as is known in the art.

While many applications (or target applications) are able to be converted into secure applications **95**, there are some applications that may not be so modified. For example, many system services **115** are default applications that are provided as part of the base configuration of the computing device **15**. The developer of the operating system that provides these system services **115** may not permit the system services **115** to be converted into secure applications **95**. As such, many system services **115** may remain as unsecure applications **90** on the computing device **15**. Accordingly, the operation of a system service **115** may not be amenable to being controlled or managed, as is the case with secure applications **95**. The relevance of this condition will be explained below.

Referring to FIG. **2**, a system **200** that shows the computing device **15** in communication with one or more remote servers **205** is shown. One or more communication networks **210** may facilitate the communications between the computing devices **15** and the remote servers **205**. In this example, the computing device **15** may be a mobile computing device, although the principles described herein may apply to desktop computers or other fixed equipment. In addition, a mobile computing device may be, for example, a smartphone, laptop, tablet or other devices that may be carried by an individual. The network(s) **210** may be composed of various types of components to support wireless or wired communications (including both). The network(s) **210** may also be configured to support local or wide area communications (or both). The remote servers **205** may host any number of web sites that offer content that may be retrieved by the computing device **15** and may also be configured to accept data from the computing device **15**. Because the servers **205** offer content, they may also be referred to as content providers, although the term "content provider" is certainly not limited to this particular example.

When operating the computing device **15**, a user may wish to access data from any one of the remote servers **205**. In some cases, the data access request may originate from an unsecure application **90**. In the standard flow, the unsecure application **90** may sometimes forward the request to a relevant system service **115**. For example, if a user wishes to view a video associated with one of the remote servers **205** through an unsecure application **90**, the unsecure application **90** passes the request to a media player of the computing device **15**. The

media player then retrieves the data from the appropriate server **205** and presents such data to the user.

In the case of a secure application **95**, a similar request would normally be passed to the media player, as well. In addition, the media player would conventionally establish a connection with the relevant remote server **205** and would present the requested data to the user. But because the system services **115** are typically not permitted to be converted into secure applications **95**, implementing the feature of data accounting in them, as can be done with secure applications **95**, may not be possible. In this instance, difficulties are presented in determining the percentage of data usage that is associated with secure applications **95** in comparison to the consumption of data by unsecure applications **90**.

A solution is described here, however, that enables such an accounting to take place. In particular, the initial data request from the secure application **95** can be intercepted and modified prior to being passed to the media player. In view of the modification, the media player (or other system service **115**) can direct the request back to the secure application **95**, and a connection can be established between the secure application **95** and the appropriate remote server **205** to facilitate the exchange of data between the secure application **95** and the remote server **205**. This redirection of the request through the secure application **95** can enable an accounting of the amount of data that is associated with this particular session, a feature that can be incorporated into secure applications **95**. Accordingly, an accurate accounting of data usage associated with at least some or all secure applications **95** on the computing device **15** is now possible.

This arrangement can enable an entity to determine the percentage of data usage that is attributable to it and to the user on a personal basis. Because data usage may be segregated between enterprise use and personal use, the enterprise may be able to craft more accurate data plans with wireless carriers or other similar entities. Moreover, the user, who may own the computing device **15**, would understand that the user would not be charged for data usage associated with that user's work or business and that the user would only be paying for personal data consumption.

Referring to FIG. **3**, a method **300** of data usage accounting is shown. The method **300**, however, may include additional or even fewer steps or processes in comparison to what is illustrated in FIG. **3**. Moreover, the method **300** is not necessarily limited to the chronological order that is shown in FIG. **3**. In describing the method **300**, reference may be made to FIGS. **1**, **2** and **4**, although it is understood that the method **300** may be practiced with any other suitable systems and components and may take advantage of other suitable processes.

At step **305**, in a setting that includes both secure applications and unsecure applications, a request to access data can be received via one of the secure applications in which the request is intended for a content provider via a system service. The request intended for the content provider via the system service can be intercepted, as shown at step **310**. At step **315**, the intercepted request can be modified, which can cause the system service to direct the request back to the secure application instead of the content provider. A connection can be established with the content provider for the request through the secure application to enable data usage accounting of data that is returned by the content provider, as shown at step **320**. Additionally, at step **325**, content from the content provider can be received at the secure application, and the received content from the content provider can be forwarded to the system service for processing, as shown at step **330**. An amount of data that is carried over the established connection associated with the secure application can be determined, as shown at step **335**.

Referring to FIGS. **1** and **2**, a user may wish to access data through, for example, a secure application **95** that is installed on the computing device **15**. As an example, the user may desire to retrieve some type of content, such as video, through the secure application **95**. The content may need to be retrieved from one of the remote servers **205**. Conventionally, the data access request would be passed to the relevant system service **115** and the system service **115** would fetch the content from the remote server **205**. Here, however, the data access request may be intercepted prior to being handled by the operating system and and can be modified to direct the request back to the secure application **95** instead of the remote server **205**. Reference will be made to FIG. **4** to help explain this process.

In FIG. **4**, an example of an interaction **400** between the secure application **95**, the system service **115** and the remote server **205** is shown. In the initial step, the data access request is received and is intercepted and modified. In this example, the data access request is for video that is stored at one of the remote servers **205** that is associated with a website or some other form of digital content, and the system service **115** is a media playback application. As such, in accordance with earlier discussion, the API that is associated with the media playback service can be hooked.

Based on conventional techniques, the uniform resource indicator (URI) related to this data request may be a uniform resource locator (URL) with the associated content available via the hypertext transfer protocol (HTTP) or the hypertext transfer protocol secure (HTTPS). As part of the modification process, the URL may be changed prior to being passed to the system service **115**. The modification of the URL, in one embodiment, may be based on a port number that is provided by the operating system. For example, the secure application **95** may create a listening socket on a loopback interface by requesting a socket and port number from the operating system. As is known in the art, the loopback interface can support inter-process or inter-app communications on the computing device **15**. The requested port may be a predetermined value or may be simply a request to the operating system to provide an available port number. Continuing with the example, the URL may be converted into a local-host URL that includes the assigned port number and the rest of the information from the original URL. The modified URL may then be passed across to the system service **115**, in this case, the media player. As will be explained later, multiple listening sockets and ports may be requested from the operating system as part of this process.

Consider the following specific but non-limiting example. A user may select a link through a secure application **95**, which may have the following exemplary URL associated with it:

http://www.youtube.com/watch?v=uWHRqspFke0

As noted earlier, the secure application **95** may request a socket and port value from the operating system, and the port value can factor into the modified URL. In this example, the original URL may be transformed into the following local-host URL:

http://localhost:
4444?t=www.youtube.com&p=watch&r=v=uWHRqspFke0

Here, the port value "4444" is now part of the URL string, which can cause the system service **115** to point back to this port created by the secure application **95**. In addition, as can be seen, the original hostname can be encoded in the "t=" parameter, the original path can be encoded in the "p="

parameter and the original parameters can be encoded in the "r=" parameter. Thus, the modified URL can include the port value, and the remote information can be added as parameters in the modified URL. A similar example for an HTTPS request will be presented below.

In some arrangements, as part of this process, the secure application **95** can create a proxy when the data is initially requested through the secure application **95**. The proxy can act as the intermediary between the system service **115** and the remote server **205**. In doing so, the proxy may listen in on any sockets that were created for the overall modification of the data access request. As an example, each secure application **95** can be individually configured to generate the proxy for relevant data requests that it receives.

In another arrangement, the secure application **95** may record a copy of the information associated with the original data request and can map that information to the redirect address that has been created. For example, in the example above, the secure application **95** may record the information associated with the original URL in any suitable database, such as the memory **70** of FIG. **1**, and can map this information to the port that was assigned to the modified URL. This way, the secure application **95** can easily determine the original remote server **205** when it receives the modified URL. In an alternative embodiment, the information of the original data request may not need to be stored and mapped to the redirect address. In the URL example, the original information from the URL can simply be obtained from the modified URL because the original information may be part of the modified information.

Moving back to FIG. **4**, in the second step, the modified data access request can cause the system service **115** to direct the request back to the secure application **95**, instead of the original remote server **205**. That is, the system service **115** will establish a connection with the secure application **95** via the port that the secure application **95** created. In view of the mapping process described above, the secure application **95** is able to determine the original data access request and can establish a connection with the relevant content provider, such as an appropriate remote server **205**. In particular, based on the example above, the secure application **95** can determine the original URL request and can open a connection with the location specified by the original URL. This process is reflected in the third step of FIG. **4**. At this point, the secure application **95** can fetch the content from the remote server **205** and can return this content to the system service **115** for processing, as shown in the fourth step. The user may then consume the requested data similar to a normal session.

As previously noted, the secure application **95** may be configured to track data usage. In this case, the secure application **95** can determine an amount of data that is carried over the connection that is established with the remote server **205**. This can include both incoming (i.e., from remote server **205** to secure application **95**) and outgoing (i.e., from secure application **95** to remote server **205**) content. For example, the calculation unit **77** of FIG. **1** can work with the secure application **95** to tally the amount of data consumed by this particular session. In addition, because each session associated with this particular secure application **95** can be tracked, a cumulative amount of data usage for the secure application **95** over a certain time period can be determined. This process may also be conducted for all or at least some of the other secure applications **95** that are installed on the computing device **15**.

If the secure applications **95** are associated with an enterprise, the enterprise can determine the amount of data usage that is tied to each of its secure applications **95**. This feature can enable the enterprise to determine data usage on the device **15** that is solely attributable to it. As a result, data usage tracking associated with the secure applications can be segregated from data usage that originates from the unsecure applications.

In one embodiment, the connection that is established between the secure application **95** and the remote server **205** can be a secure connection. For example, as is known in the art, the secure application **95** can be configured to establish virtual private network (VPN) connections with remote locations. Such a VPN connection is individual to the secure application **95** and is different from a system-level VPN. If desired, however, the connection between the secure application **95** and the remote server **205** is not required to be a secure connection. In addition, in another embodiment, the secure application **95** may use a system-level VPN.

The description above may apply to other protocols that facilitate the exchange of data. For example, HTTPS traffic may also be tracked in accordance with the procedures presented herein. In one embodiment, additional steps can be taken when dealing with HTTPS traffic to ensure accurate and complete accounting. For example, if a user is accessing an HTTPS link through the secure application **95**, the original URL may be modified similar to the HTTP examples above, but the connection between the system service **115** and the secure application **95** may be left in the open.

Consider the following example. If an HTTPS request is generated, the secure application **95** can convert the HTTPS request to an HTTP request when the secure application **95** modifies the URL for purposes of directing the system service **115** back to the secure application **95**. That is, the secure application **95** can change the connection type of the data request from a secure connection to an open connection when the data request is modified. Referring back to the URL example above, the following HTTPS URL may be received:

https://www.youtube.com/watch?v=uWHRqspFke0

The secure application **95** can determine that this is an HTTPS request and can modify the URL. An exemplary conversion is presented here:

http://localhost:
4444?s=www.youtube.com&p=watch&r=v=uWHRqspFke0

As reflected in the string, the HTTPS request is converted to an HTTP request. As a result, the connection between the system service **115** and the secure application **95** can be out in the open. As will be explained below, this feature can enable the secure application **95** to handle re-directs from the remote server **205**.

As can also be seen in the string, the "s=" parameter can provide an indication that the original URL was an HTTPS request. Accordingly, when the secure application **95** establishes the connection between it and the remote server **205**, an HTTPS connection can be created. In other words, the system service **115** may not be responsible for establishing the HTTPS connection, and the secure application **95** may be in control of any security-related handshaking and getting the encryption keys in place. The session between the secure application **95** and the remote server **205** can be a transport layer security (TLS) connection, which can terminate at the secure application **95**.

As explained earlier, the secure application **95** may be configured to arrange VPN connections in an individual manner. Such an application-level VPN can support any type of traffic that is exchanged between the secure application **95** and the remote server **205**, including both HTTP and HTTPS streams. In other words, the ability of the secure application **95** to provide an application-level VPN does not impede the ability of the secure application **95** to modify data access

requests and then convert them back to their original form, as described above. Further, these techniques can be practiced if the secure application **95** is using a system-level VPN or is not relying on a VPN connection at all.

As is known in the art, some initial data access requests are answered with a re-direct, which instructs the requesting source to another destination to retrieve the desired content. For example, in the case of an HTTP request, the requesting device may receive an HTTP re-direct from the server, which causes the device to generate another HTTP request based on the re-direct destination. In addition, in some cases, a URL playlist may be sent from the server, which may include a plurality of URLs. This particular feature may support HTTP live-streaming, a protocol that enables a client to select from a number of different alternate streams containing the same material encoded at a variety of data rates, which can allow the streaming session to adapt to the available data rate.

In one arrangement, the secure application **95** may be configured to account for these re-directs. For example, if the initial data request is an HTTP request and the remote server **205** returns an HTTP re-direct, the secure application **95** may transform that HTTP re-direct in accordance with the modification process described above. By doing so, the secure application **95** can ensure that the system service **115** establishes the new re-direct connection with the secure application **95**. As such, when the secure application **95** detects a re-direct, the secure application **95** can request another socket and port from the operating system to account for the new destination that originates from the re-direct. The secure application **95** can then open a connection between itself and the new (and appropriate) remote server **205**. This process can be expanded to account for re-direct playlists, such that socket/port pairs are generated when needed for the URLs that make up the playlists.

As can be gleaned from this example, the secure application **95** may be required to detect the re-directs in the incoming streams. If the original data access request is not based on a secure protocol, like HTTPS, then the secure application **95** is easily able to detect the re-directs. If the original request is based on a secure protocol, however, complications may arise because the traffic being streamed to the system service may be encrypted. As noted above, when dealing with a secure protocol, the termination point for the secure connection can be placed at the secure application **95**, not the system service **115**. As a result, the secure application **95** can decrypt the incoming traffic and can detect the re-directs, similar to how it would for an unsecure protocol. Thus, as an example, re-directs can be handled for both HTTP and HTTPS.

In some cases, other components may assist in the calculation of data for purposes of usage accounting. For example, some system services **115** may offer notifications based on certain events that may be related to data usage. In one particular example, the secure applications **95** can register for certain callbacks from the system services **115** that are equipped to provide such notifications. As an example, if a data session is initiated through a secure application **95**, the system service **115** can provide one or more notifications that inform the secure application **95** of the start of the session and its eventual ending. Statistics related to the amount of data that was consumed during the session can be incorporated into the notifications, which the secure application **95** can use to track its data usage. The overall total usage related to all or at least some of the secure applications **95** can be determined, which can allow the segregation of data consumption between secure and personal profiles, as described earlier. In this case, however, the modification of the data access requests is not required, and the system service may fetch data in its conventional manner. When available with the system services **115**, this feature may be useful for data accounting, particularly when application-level VPNs are not incorporated into the secure applications **95**.

The description herein has been presented primarily in terms of a secure application **95** handling the modification of data requests and the data usage tracking. The description, however, is not so limited. In particular, these features can be implemented into an unsecure application such that data usage can be tracked for these types of applications on an individual basis. Similarly, the system service that is involved in this process is not limited to a media player. In fact, any system service that is involved in the exchange of data with a remote location may be applicable to the description provided herein. For example, other system services that apply here may include a texting application, a dialer or any other application that facilitates or otherwise supports voice communications, a video or camera application, or a map application or other application that supports mapping features. In fact, the description herein may apply to any type of application, whether secure or unsecure, that may involve the consumption of content or the use of services in which it may be necessary to distinguish between personal use of such content and services and secure or workspace or enterprise use of the content and services.

While various embodiments have been described above, it should be understood that they have been presented by way of example only, and not limitation. It will be understood by those skilled in the relevant art(s) that various changes in form and details may be made therein without departing from the spirit and scope of the subject matter as defined in the appended claims. Accordingly, the breadth and scope of the present subject matter should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

The flowchart and block diagrams in the figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods and computer program products according to various embodiments. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of code, which comprises one or more executable instructions for implementing the specified logical function(s). It should also be noted that, in some alternative implementations, the functions noted in the block may occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved.

What is claimed is:

1. A method of segregated data usage accounting on a computing device, comprising:

launching a secure application that is installed on the device;

through the secure application, generating a content request for content from a content provider;

directing the content request from the secure application to a system application to enable functions of the system application to be invoked in fulfillment of the request, wherein the system application is an unsecure application that provides a service to the secure application;

redirecting the content request from the system application to the secure application to enable data usage accounting of the content returned by the content provider responsive to the content request;

establishing a connection between the content provider and the secure application for delivery of the content; and

as part of establishing the connection between the content provider and the secure application for delivery of the content, directing the connection to a remote location to enable an amount of data that is delivered to the secure application to be remotely calculated in response to the content request such that data usage of the computing device originating from the secure application is calculated separately from data usage not originating from the secure application.

2. The method according to claim **1**, wherein directing the content request from the secure application to the system application comprises:

intercepting the content request from the secure application; and

modifying the content request from the secure application to cause the redirection of the content request from the system application to the secure application.

3. The method according to claim **2**, wherein modifying the content request comprises changing a uniform resource locator (URL) associated with the requested content.

4. The method according to claim **1**, wherein directing the content request from the secure application to a system application comprises establishing a connection between the system application and the secure application.

5. The method according to claim **4**, wherein the connection between the content provider and the secure application is a secure connection.

6. The method according to claim **5**, wherein the connection between the system application and the secure application is an unsecure connection.

7. The method according to claim **1**, wherein the system application is a media player.

8. The method according to claim **1**, wherein the system application is a system application that is installed by default on the computing device by a manufacturer of the computing device or by a wireless carrier that provides services to the computing device.

9. A computing device, comprising:

a display that is configured to display both secure and unsecure applications that are installed on the computing device;

a processor that is communicatively coupled to the display, wherein the processor is configured to:

receive a data access request through one of the secure applications, wherein the data request is supported by an unsecure application that is a system service of the computing device that provides a service to the secure application;

cause the data access request to be directed from the secure application to the system service and to be redirected back to the secure application from the system service;

cause a connection between the secure application and an intended location of the data access request to be established to enable data associated with the data access request to be facilitated through the secure application; and

cause the connection between the secure application and an intended location of the data access request to be established by at least directing the connection to a remote calculation unit to enable the remote calculation unit to determine an amount of the data that is associated with the data access request through the secure application such that data usage of the computing device originating from the secure application is calculated separately from data usage not originating from the secure application.

10. The computing device according to claim **9**, wherein the processor is configured to cause the data access request to be redirected back to the secure application by:

causing the data access request to be intercepted prior to processing by the system service; and

causing the data access request to be modified to enable the redirection of the data access request.

11. The computing device according to claim **9**, wherein the processor is further configured to cause the encryption or decryption of the data that is associated with the data access request such that a secure connection between the secure application and the intended location terminates at the secure application.

12. The computing device according to claim **9**, wherein the processor is further configured to forward the data that is associated with the data access request to the system service for processing.

13. The computing device according to claim **9**, wherein the system service is a media player installed on the computing device.

14. The computing device according to claim **9**, wherein the system service is installed by default on the computing device by a manufacturer of the computing device or by a wireless carrier that provides services to the computing device.

15. A method of segregated data usage accounting on a computing device, comprising:

launching an enterprise application that is installed on the device, wherein the enterprise application has been identified for data usage accounting separate from personal applications installed on the device;

through the enterprise application, generating a content request requesting content from a content provider server that is remotely located;

directing the content request from the enterprise application to a system application to invoke functions of the system application in fulfillment of the content request;

redirecting the content request from the system application to the enterprise application to enable data usage tracking of the device originating from the enterprise application separately from data usage not originating from the enterprise application;

as part of enabling data usage tracking, instead of conventionally directing the content request to the content provider server, redirecting the content request to a separate remote system to enable remote calculation of an amount of consumed data associated with the content request to be determined; and

responsive to redirection of the content request, receiving from the content provider server the data associated with the content request.

16. The method according to claim **15**, wherein redirecting the content request comprises re-directing the content request to a proxy that serves as an intermediary between a system service involved with the content request through the enterprise application and the content provider server.

17. The method according to claim **15**, wherein the system service involved with the content request is a media player that is configured to present video to a user of the computing device.

18. The method according to claim **15**, wherein redirecting the content request comprises intercepting the content request from the enterprise application to enable the redirecting of the content request.

19. The method according to claim 15, wherein receiving from the content provider server the data associated with the content request comprises receiving from the content provider server the data associated with the content request over a virtual private network (VPN) connection.

20. The method according to claim 19, wherein the VPN connection is a VPN connection that is individual to the enterprise application through which the content request originates or a system-level VPN.

21. The method according to claim 15, wherein the enterprise application that is launched and requests content from the content provider server is a secure application and the personal applications are unsecure applications.

22. A non-transitory storage medium that has executable instructions stored thereon, wherein when the executable instructions are executed by a computing device, the executable instructions cause the computing device to:

launch a secure application that is installed on the device;

through the secure application, generate a content request for content from a content provider;

direct the content request from the secure application to a system application to enable functions of the system application to be invoked in fulfillment of the request, wherein the system application is an unsecure application that provides a service to the secure application;

redirect the content request from the system application to the secure application to enable data usage accounting of the content returned by the content provider responsive to the content request;

establish a connection between the content provider and the secure application for delivery of the content; and

as part of establishing the connection between the content provider and the secure application for delivery of the content, directing the connection to a remote location to enable an amount of data that is delivered to the secure application to be remotely calculated separately from data usage not originating from the secure application in response to the content request.

23. The non-transitory storage medium according to claim 22, wherein when the executable instructions are executed by the computing device, the executable instructions further cause the computing device to direct the content request from the secure application to the system application by:

intercepting the content request from the secure application; and

modifying the content request from the secure application to cause the redirection of the content request from the system application to the secure application.

24. The non-transitory storage medium according to claim 23, wherein when the executable instructions are executed by the computing device, the executable instructions further cause the computing device to modify the content request by changing a uniform resource locator (URL) associated with the requested content.

25. The non-transitory storage medium according to claim 22, wherein when the executable instructions are executed by the computing device, the executable instructions further cause the computing device to direct the content request from the secure application to the system application by establishing a connection between the system application and the secure application.

26. The non-transitory storage medium according to claim 22, wherein the connection between the system application and the secure application is an unsecure application and the connection between the secure application and the content provider server is a secure connection.

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